

What is claimed is:

1. A method of automated handling of a set of previously harvested seed comprising: (a) providing a unique identifier to a set of seed; (b) automatically  
5 performing one or more operations on the set of seed; (c) automatically accumulating an end product from the set of seed and storing information about the end product correlated to the identifier.
2. The method of claim 1 further comprising  
10 segregating the set of seed from a second set of seed.
3. The method of claim 1 further comprising a plurality of sets of previously harvested seeds, each provided with a unique identifier, automatically performing said one or more operations while tracking and segregating  
15 each set of seed from each other.
4. The method of claim 1 further comprising monitoring said operations for conditions indicative of an error.
5. The method of claim 3 wherein the conditions  
20 indicative of an error comprise one or more of (a) over capacity, (b) possibility of commingling of sets of seed, (c) improper operation; (d) lack of validation against a data set; (e) improper set of seeds relative to operational set-up.
- 25 6. The method of claim 3 further comprising regulating movement of a set of seed to deter reaching over-capacity for any operation.

7. The method of claim 1 wherein progression of a said set of seeds through said one or more operations is controlled while maintaining segregation of the set of seeds.

5 8. The method of claim 6 wherein control of progression comprises maintaining spatial separation of each set of seeds operating on the seeds and allowing recovery of each set of seeds while preserving its identity from other sets of seeds.

10 9. The method of claim 2 further comprising conveying said set of seed to an outlet wherein said tracking provides information used to verify which set of seed is at the outlet.

15 10. The method of claim 2 further comprising conveying said set of seed to and through said one or more operations, said tracking providing information to verify the location of the set of seed between input and output.

20 11. The method of claim 9 wherein the tracking comprising tracking the state of the operations relative the set of seeds.

12. The method of claim 10 wherein the state of the operations includes monitoring status of devices that control conveyance of the set of seeds.

25 13. The method of claim 1 wherein the sets of seed are seed samples.

14. The method of claim 12 wherein the seed samples are related to a plant breeding program.

15. The method of claim 13 wherein the plant breeding program is a corn breeding program.

16. The method of claim 13 wherein the plant breeding program is a soybean breeding program.

5        17. The method of claim 1 wherein the operations comprise one or more of (a) separating a set of seed from a carrier or adhering vegetation, tissues or structure, (b) cleaning, (c) discriminating between seeds in the set of seeds, (d) counting, (e) measuring moisture content, (f) measuring weight, (g) evaluating non-destructively, (h) measuring temperature.

18. The method of claim 1 further comprising directing said end product into a container.

15        19. The method of claim 4 wherein said data set comprises a data base, a spreadsheet, or a mapped memory.

20. The method of claim 4 further comprising generating a label for the set of seed or subset thereof based at least in part on information from the data set.

20        21. The method of claim 1 wherein the operations are self-cleaning.

22. The method of claim 20 wherein the operations include a cleaning/size sorting operation which is self-cleaning.

25        23. The method of claim 1 further comprising generating a notification for transmission to a remote location related to accumulated data regarding the set of seed and communicating the notification.

24. The method of claim 1 further comprising separating undesired non-seed material and some seeds from the set of seeds during said one or more operations.

25. The method of claim 23 wherein said separated non-  
5 seed material and said some seeds are either discarded or accumulated for possible future use.

26. The method of claim 1 wherein the operations are programmable dependent upon selected parameters.

27. The method of claim 25 wherein the parameters are  
10 related to differences between different types of seeds or differences between conditions of the same type of seeds.

28. An apparatus for automatically handling of a set of previously harvested seeds comprising a plurality of seeds of like characteristics comprising: (a) a seed input;  
15 (b) a seed output; (c) a handling system operatively associated with the input and output; (d) a controller which (d1) accepts or assigns an ID to a set of seeds, (d2) controls the processing of the set of seeds to the outlet and, (d3) controls accumulation of seed from the set of seed  
20 into an end product and accumulation of information about seed from the set of seed and correlates the same with the ID.

29. The apparatus of claim 27 wherein the machine-readable ID is a bar code.

25 30. The apparatus of claim 27 wherein the machine-readable ID is a RF ID tag.

31. The apparatus of claim 27 wherein the processing system includes a programmable processor, a seed processing device, and a conveyance component.

32. The apparatus of claim 30 wherein the programmable  
5 processor comprises a programmable data acquisition device for process control.

33. The apparatus of claim 31 wherein the programmable processor is a computer.

34. The apparatus of claim 31 wherein the programmable  
10 processor is a programmable logic controller (PLC).

35. The apparatus of claim 27 further comprising actuators, controlled by the processing system, adapted to control timing and conveyance of the sets of seed.

36. The apparatus of claim 34 further comprising a  
15 sensor adapted to sense the state of an actuator.

37. The apparatus of claim 35 wherein the processing system is programmed to control the operation of the actuators to keep spatial separation between certain sets of seeds while being simultaneously processed by the apparatus.

20 38. The apparatus of claim 36 wherein the programming maintains spatial separation by a timing regime implemented by said processor for controlling the actuators.

39. The apparatus of claim 37 further comprising using a set of sensors to report a state of a set of actuators  
25 relative to time to allow said processing system to track each set of seeds through the processing.

40. The apparatus of claim 38 further comprising programmed safeguards to control, stop or delay processing upon sensing of a certain condition.

41. The apparatus of claim 39 wherein said certain  
5 condition relates to amount of seed, state of actuators, or feed rate of seeds.

42. The apparatus of claim 27 wherein said operations comprise one or more of (a) separating seeds from a carrier or adhering vegetation, tissues or structure, (b) separating  
10 seed from non-seed or damaged seed, (c) sorting seeds based on a characteristic of the seed.

43. The apparatus of claim 27 further comprising a database associated with the processing system.

44. The apparatus of claim 42 further comprising a  
15 communication link between said database and a second database.

45. A method for processing seed derived from an experimental plot comprising: (a) correlating a seed sample to a plot; (b) assigning or accepting correlation  
20 information for said seed sample; (c) performing operations on the seed sample; (d) accumulating at least some of the sample; (e) non-destructively deriving/measuring one or more characteristics of the accumulated seed; (f) storing a derived/measured characteristic; (g) collecting the  
25 accumulated seed for further use.

46. The method of claim 44 wherein the seed is corn seed.

47. The method of claim 45 wherein the seed is originally attached to its carrier, a cob.

48. The method of claim 44 wherein the seed is soybean seed.

5 49. The method of claim 47 wherein the soybean seed is originally attached to its carrier, a soybean plant or part thereof.

50. The method of claim 44 wherein the processing is in association with a plant breeding experiment.

10 51. The method of claim 44 wherein the correlation step comprises associating a machine-readable tag with one or more carriers, or vegetation, tissues or structures containing said seed sample; machine-reading the tag; and validating information on the tag to a data base related to  
15 the experiment.

52. The method of claim 44 wherein the operations comprise at least one of the following: (a) separating the seed from a carrier, (b) cleaning, (c) sorting based on size, (d) sorting based on other than size and the step of  
20 deriving/measuring comprises at least of one of: (a) weight, (b) moisture content; (c) number of seeds; (d) constituents of the seeds, (e) temperature of the seeds.

53. The method of claim 44 further comprising communicating to one or more databases information related  
25 to said seeds, said operations and/or said deriving/measuring.

54. The method of claim 52 further comprising generating a label that can be associated with the collected seed based on the updated database.

55. The method of claim 44 further comprising  
5 generating a communication related to the accumulated seed for transmission to a predetermined addressee.

56. The method of claim 54 wherein the communication comprises one or more of (a) identification of accumulated seed, (b) time/date of harvest of seed, (c) time/date of  
10 performance of said operations on the seed.

57. The method of claim 44 further comprising simultaneously processing a plurality of samples.

58. The method of claim 56 further comprising controlling movement of and operations on said seed to  
15 maintain separation of seed from one sample of seed from other samples.

59. The method of claim 57 wherein separation is achieved by disallowing any seed for one sample to move to a location occupied by seed from another sample.

20 60. The method of claim 57 wherein separation is achieved by sequencing operations so that an operation on a succeeding seed sample can not begin until that operation on an immediately preceding seed sample is deemed completed.

61. The method of claim 44 further comprising the  
25 operation of sizing seeds by a self-cleaning perforated sizing screen comprising: moving one of a surface and the sizing screen towards the other.



62. The method of claim 44 wherein the correlation information is compared to a data set.

63. The method of claim 44 further comprising directing pressurized air towards the screen or surface.

5        64. An apparatus for processing corn seed derived from an experimental plot comprising: (a) a device including a component for sorting seed based on sensed characteristics of the seed; (b) a programmable controller; (c) a conveyance system controlled by the programmable controller and adapted  
10 to convey seed from the sorting component and to a packaging station.

65. The apparatus of claim 63 for processing ear corn or unthreshed soybeans further comprising a device to shell or thresh in a conveyance path positioned prior to the  
15 sorter.

66. The apparatus of claim 63 further comprising a cleaner device positioned in a conveyance path.

67. The apparatus of claim 63 further comprising a machine vision device to automatically read information  
20 related to a set of seed.

68. The apparatus of claim 66 further comprising operative connection to a computer having a database.

69. The apparatus of claim 63 further comprising a label applicator device for printing a machine-readable  
25 label to a container for holding seeds.

70. The apparatus of claim 63 further comprising a sensor to track movement and location of the seed in the apparatus.

71. The apparatus of claim 63 further comprising a  
5 non-destructive analyzer positioned adjacent to the conveyance path adapted to sense a characteristic of the seed.

72. The apparatus of claim 70 wherein the characteristics are selected from the set comprising weight,  
10 color, moisture, chemical properties, physical properties, temperature.

73. The apparatus of claim 63 further comprising a cleaner device including a self-cleaning sizing screen comprising: a cleaning member having a surface generally  
15 corresponding in width to a screen to be cleaned; a dedicated actuator associated with one of the cleaning member and the sizing screen to bring said one of the cleaning member and the sizing screen towards the other.

74. The apparatus of claim 72 further comprising said  
20 surface corresponding in width and length to the screen to be cleaned.

75. The apparatus of claim 73 wherein the sizing screen is a flat screen.

76. The apparatus of claim 74 wherein one of the  
25 cleaning member and the sizing screen is positioned to move towards the other.

77. A method of handling sets of corn seed comprising:  
(a) validating the identity of a previously harvested ear  
corn sample; (b) shelling the ear corn; (c) autonomously  
sorting the shelled corn based on characteristics  
5 automatically non-destructively sensed from the shelled  
corn; (d) maintaining, in isolation from other seeds, a  
selected set of the sorted seeds; (e) accumulating the  
isolated set of sorted seeds for further use.

78. The method of claim 76 wherein the autonomous  
10 sorting comprises color sorting the shelled corn based on  
pre-programmed criteria.

79. The method of claim 76 wherein the characteristics  
are selected from the set comprising weight, color,  
moisture, chemical properties, physical properties,  
15 temperature.

80. The method of claim 76 wherein the sensing is by  
spectroscopy.

81. The method of claim 79 where the spectroscopy is  
near infrared spectroscopy.

20 82. The method of claim 76 wherein the sensing is by  
non-destructive analysis.

83. The method of claim 76 further comprising cleaning  
the seed.

84. The method of claim 76 further comprising scalping  
25 the shelled corn prior to sorting.

85. The method of claim 76 further comprising sizing  
the shelled corn prior to sorting.

86. The method of claim 84 wherein the sizing is by size of the seed.

87. The method of claim 84 wherein the sizing is by shape of the seed.

5 88. The method of claim 76 further comprising counting the autonomously sorted shelled seed.

89. The method of claim 87 further comprising bagging a pre-determined quantity of the counted seed.

90. The method of claim 76 further comprising  
10 automatically controlling and tracking the conveyance of the corn during the process.

91. The method of claim 76 further comprising controlling the timing of conveyance of the seed.

92. The method of claim 76 further comprising cleaning  
15 the sample on a perforated sizing screen and self-cleaning the sizing screen by moving of one a surface and a side of the sizing screen to the other.

93. The method of claim 91 wherein a said screen is a flat screen and said surface is a flat corresponding  
20 surface.

94. A method of handling sets of soybean seed comprising: (a) validating the identity of a previously harvested soybean plant sample; (b) threshing the soybean plant; (c) autonomously sorting the threshed soybean seeds  
25 based on characteristics automatically non-destructively sensed from the soybean seeds; (d) maintaining, in isolation from other seeds, a selected set of the sorted seeds; (e)

accumulating the isolated set of sorted seeds for further use.

95. The method of claim 93 wherein the characteristics are selected from the set comprising weight, moisture,  
5 chemical properties, physical properties, temperature.

96. The method of claim 93 wherein the sensing is by spectroscopy.

97. The method of claim 95 where the spectroscopy is near infrared spectroscopy.

10 98. The method of claim 93 wherein the sensing is by non-destructive analysis.

99. The method of claim 93 further comprising cleaning the seed.

100. The method of claim 93 further comprising sizing  
15 the seed prior to sorting.

101. The method of claim 99 wherein the sizing is by shape of the seed.

102. The method of claim 93 further comprising counting the seed.

20 103. The method of claim 101 further comprising bagging a pre-determined quantity of the counted seed.

104. The method of claim 93 further comprising automatically controlling and tracking the conveyance of the soybean seed during the process.

25 105. An apparatus for automatically processing previously harvested seed samples for a corn plant breeding program comprising: (a) a harvest tag including machine

readable identification information associated with each sample of a plurality of samples; (b) a sheller having an input and an output; (c) an automated cleaner/size sorter having an input and an output; (d) an automated machine vision sorter having an input and an output; (e) a bagging station having an input and an output; (f) an automatic conveyance system between (b) and (c), (c) and (d) and (d) and (e); (g) a sensor of a characteristic of the sample or the state of a sample; (h) a controller operatively  
5 connected to the conveyance system adapted to instruct operation of the conveyance system and to track and maintain segregation of a sample or subset of a sample through the apparatus.

106. The apparatus of claim 104 wherein the machine  
15 vision sorter is a color sorter.

107. The apparatus of claim 104 wherein the controller is programmable to different processing regimes.

108. The apparatus of claim 104 wherein the controller is programmable to handle one seed sample in batch mode;  
20 multiple seed samples in sequential continuous processing mode; or multiple sub-sets of one seed sample in sequential continuous processing mode.

109. The apparatus of claim 104 further comprising operative communication between the controller and a  
25 database for parallel information flow to progression of a sample through the apparatus.

110. The apparatus of claim 104 further comprising an apparatus to self-clean sizing screens comprising: a cleaning member having a surface generally corresponding in width to a screen to be cleaned; a dedicated actuator associated with the cleaning member; a cleaning member normally positioned adjacent the screen; the actuator operable to move one of the cleaning member or the screen from its normal position to directly in abutment with the other.

111. The apparatus of claim 109 wherein the screen is a flat screen and the cleaning member is a flat corresponding surface.

112. A system for processing seed samples comprising: (a) a processor adapted to be in communication with a data base; (b) a seed processing device under programmable control by said processor; (c) a sensing device in operative communication with said processor; (d) a conveying mechanism under control by said processor.

113. The system of claim 111 wherein said database comprises one or more of a local database and/or a central data base.

114. The system of claim 111 wherein said processing device comprises one or more of (a) a separator of seed from a carrier or other non-seed material, (b) a cleaner, (c) a sorter.

115. The system of claim 111 further comprising a bagging station including a container to hold accumulated processed seed in a form ready for bagging.

116. A method of corn seed quality management  
5 comprising: (a) identifying a sample of corn seed; (b) separating the sample on the basis of physical characteristic of the corn seed into a desired corn seed group and a discard group; (c) maintaining the discard group for each sample separately from the desired group and  
10 separately from the discard groups of other samples; (d) Packaging the desired group into discrete packages; (e) identifying the package; (f) maintaining information on the seed sample in a database.

117. The method of claim 115 further comprising  
15 reviewing the discard group for possible future use.

118. The method of claim 115 further comprising using the information to manage a seed inventory.